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Title:
A GOLF BALL HAVING A TUBULAR LATTICE PATTERN

Abstract:

A golf ball (20) approaching zero land area is disclosed herein. The golf ball (20) has an innersphere (21) with a plurality of tubular projections (40). Each of the plurality of projections (40) has an apex (50) that extends to a height to conform with the 1.68 inches requirement for USGA approved golf balls. The tubular lattice pattern on the inner sphere (21) of the golf ball (20) of the present invention has interconnected projections (40) that form a plurality of hexagons and pentagons in the preferred embodiment. The preferred embodiment has a parting line (100) that alternates upward and downward along adjacent rows of hexagons.

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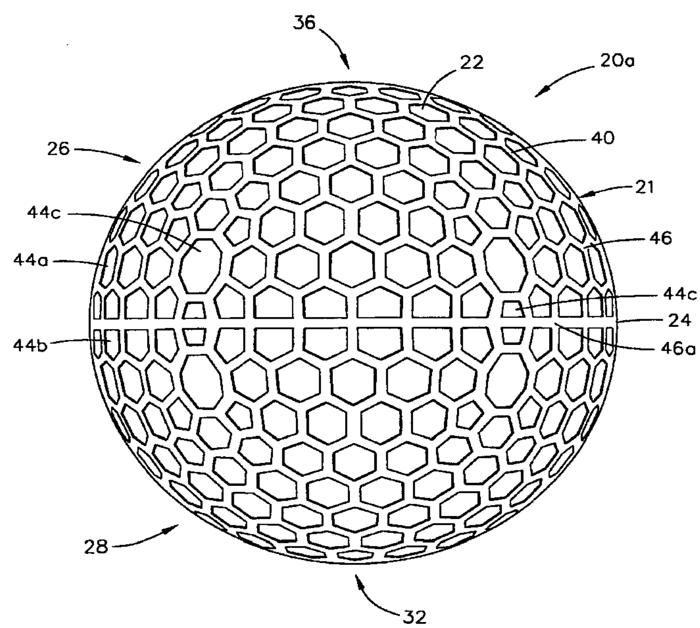

(57) Abstract: A golf ball (20) approaching zero land area is disclosed herein. The golf ball (20) has an innersphere (21) with a plurality of tubular projections (40). Each of the plurality of projections (40) has an apex (50) that extends to a height to conform with the 1.68 inches requirement for USGA approved golf balls. The tubular lattice pattern on the inner sphere (21) of the golf ball (20) of the present invention has interconnected projections (40) that form a plurality of hexagons and pentagons in the preferred embodiment. The preferred embodiment has a parting line (100) that alternates upward and downward along adjacent rows of hexagons.

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Title

A GOLF BALL HAVING A TUBULAR LATTICE PATTERN

Technical Field

The present invention relates to an aerodynamic surface pattern for a golf ball. More specifically, the present invention relates to a golf ball having a tubular lattice pattern on an innersphere surface.

Background Art

Golfers realized perhaps as early as the 1800's that golf balls with indented surfaces flew better than those with smooth surfaces. Hand-hammered gutta-percha golf balls could be purchased at least by the 1860's, and golf balls with brambles (bumps rather than dents) were in style from the late 1800's to 1908. In 1908, an Englishman, William Taylor, received a British patent for a golf ball with indentations (dimples) that flew better ad more accurately than golf balls with brambles. A.G. Spalding & Bros., purchased the U.S. rights to the patent (embodied possibly in U.S. Patent Number 1,286,834 issued in 1918) and introduced the GLORY ball featuring the TAYLOR dimples. Until the 1970s, the GLORY ball, and most other golf balls with dimples had 336 dimples of the same size using the same pattern, the ATTI pattern. The ATTI pattern was an octohedron pattern, split into eight concentric straight line rows, which was named after the main producer of molds for golf balls.

The only innovation related to the surface of a golf ball during this sixty year

period came from Albert Penfold who invented a mesh-pattern golf ball for Dunlop. This pattern was invented in 1912 and was accepted until the 1930's. A combination of a mesh pattern and dimples is disclosed in Young, U.S. Patent Number 2,002,726, for a Golf Ball, which issued in 1935.

The traditional golf ball, as readily accepted by the consuming public, is spherical with a plurality of dimples, with each dimple having a circular cross-section. Many golf balls have been disclosed that break with this tradition, however, for the most part these non-traditional golf balls have been commercially unsuccessful.

Most of these non-traditional golf balls still attempt to adhere to the Rules Of Golf as set forth by the United States Golf Association ("USGA") and The Royal and Ancient Golf Club of Saint Andrews ("R&A"). As set forth in Appendix III of the Rules of Golf, the weight of the ball shall not be greater than 1.620 ounces avoirdupois (45.93 gm), the diameter of the ball shall be not less than 1.680 inches (42.67 mm) which is satisfied if, under its own weight, a ball falls through a 1.680 inches diameter ring gauge in fewer than 25 out of 100 randomly selected positions, the test being carried out at a temperature of 23±1°C, and the ball must not be designed, manufactured or intentionally modified to have properties which differ from those of a spherically symmetrical ball.

One example is Shimosaka et al., U.S. Patent Number 5,916,044, for a Golf Ball that discloses the use of protrusions to meet the 1.68 inch (42.67mm) diameter limitation of the USGA and R&A. The Shimosaka patent discloses a golf ball with a

plurality of dimples on the surface a few rows of protrusions that have a height of 0.001 to 1.0 mm from the surface. Thus, the diameter of the surface is less than 42.67mm.

Another example of a non-traditional golf ball is Puckett et al., U.S. Patent Number 4,836,552 for a Short Distance Golf Ball, which discloses a golf ball having brambles instead of dimples in order to reduce the flight distance to half of that of a traditional golf ball in order to play on short distance courses.

Another example of a non-traditional golf ball is Pocklington, U.S. Patent Number 5,536,013 for a Golf Ball, which discloses a golf ball having raised portions within each dimple, and also discloses dimples of varying geometric shapes such as squares, diamonds and pentagons. The raised portions in each of the dimples of Pocklington assists in controlling the overall volume of the dimples.

Another example is Kobayashi, U.S. Patent Number 4,787,638 for a Golf Ball, which discloses a golf ball having dimples with indentations within each of the dimples. The indentations in the dimples of Kobayashi are to reduce the air pressure drag at low speeds in order to increase the distance.

Yet another example is Treadwell, U.S. Patent Number 4,266,773 for a Golf Ball, which discloses a golf ball having rough bands and smooth bands on its surface in order to trip the boundary layer of air flow during flight of the golf ball.

Aoyama, U.S. Patent Number 4,830,378, for a Golf Ball With Uniform Land Configuration, discloses a golf ball with dimples that have triangular shapes. The total flat land area of Aoyama is no greater than 20% of the surface of the golf ball, and the

objective of the patent is to optimize the uniform land configuration and not the dimples.

Another variation in the shape of the dimples is set forth in Steifel, U.S.Patent Number 5,890,975 for a Golf Ball And Method Of Forming Dimples Thereon. Some of the dimples of Steifel are elongated to have an elliptical cross-section instead of a circular cross-section. The elongated dimples make it possible to increase the surface coverage area. A design patent to Steifel, U.S. Patent Number 406,623, has all elongated dimples.

A variation on this theme is set forth in Moriyama et al., U.S. Patent Number 5,722,903, for a Golf Ball, which discloses a golf ball with traditional dimples and oval shaped dimples.

A further example of a non-traditional golf ball is set forth in Shaw et al., U.S. Patent Number 4,722,529, for Golf Balls, which discloses a golf ball with dimples and 30 bald patches in the shape of a dumbbell for improvements in aerodynamics.

Another example of a non-traditional golf ball is Cadorniga, U.S. Patent Number 5,470,076, for a Golf Ball, which discloses each of a plurality of dimples having an additional recess. It is believed that the major and minor recess dimples of Cadorniga create a smaller wake of air during flight of a golf ball.

Oka et al., U.S. Patent 5,143,377, for a Golf Ball, discloses circular and non-circular dimples. The non-circular dimples are square, regular octagonal, regular hexagonal and amount to at least forty percent of the 332 dimples on the golf ball of

Oka. These non-circular dimples of Oka have a double slope that sweeps air away from the periphery in order to make the air turbulent.

Machin, U.S. Patent Number 5,377,989, for Golf Balls With Isodiametrical Dimples, discloses a golf ball having dimples with an odd number of curved sides and arcuate apices to reduce the drag on the golf ball during flight.

Lavallee et al., U.S. Patent Number 5,356,150, discloses a golf ball having overlapping elongated dimples to obtain maximum dimple coverage on the surface of the golf ball.

Oka et al., U.S. Patent Number 5,338,039, discloses a golf ball having at least forty percent of its dimples with a polygonal shape. The shapes of the Oka golf ball are pentagonal, hexagonal and octagonal.

Although the prior art has set forth numerous variations for the surface of a golf ball, there remains a need for a golf ball having a surface that minimizes the volume needed to trip the boundary layer of air at low speed while providing a low drag level at high speeds.

Disclosure of the Invention

The present invention is able to provide a golf ball that meets the USGA requirements, and provides a minimum land area to trip the boundary layer of air surrounding a golf ball during flight in order to create the necessary turbulence for greater distance. The present invention is able to accomplish this by providing a golf

ball with a tubular lattice pattern on a surface of an innersphere.

One aspect of the present invention is a golf ball with an innersphere having a surface and a plurality of tubular projections disposed on the innersphere surface. Each of the tubular projections has a cross-sectional contour with an apex at the greatest extent from the center of the golf ball. The plurality of tubular projections are connected to each other to form a predetermined pattern on the surface. Each of the tubular projections extend from 0.005 inches to 0.010 inches from the innersphere surface.

The plurality of tubular projections on the golf ball may cover between 20% to 80% of the surface of the innersphere surface. The apex of each of the plurality of tubular projections has a width less than 0.00001 inches. The diameter of the innersphere may be at least 1.67 inches and the height of the apex of each of the plurality of connected tubes may be at least 0.005 inches from the surface of the innersphere. The golf ball may also include a plurality of smooth portions on the innersphere surface wherein the plurality of smooth portions and the plurality of tubular projections cover the entire innersphere surface.

Brief Description of the Drawings

FIG. 1 is an equatorial view of a golf ball of the present invention.

FIG. 2 is a polar view of the golf ball of FIG. 1.

FIG. 3 is an enlargement of a section of FIG. 1.

FIG. 4 is an enlargement of a section of FIG. 3

FIG. 4A is a cross-sectional view of the surface of the golf ball of the present invention illustrating a phantom sphere.

FIG. 5 is a cross-sectional view of one embodiment of projections of the golf ball of the present invention.

FIG. 6 is a cross-sectional view of an alternative embodiment of projections of the golf ball of the present invention.

FIG. 6A is a top plan view of FIG. 6 to illustrate the width of the apex of each of the projections.

FIG. 7 is an isolated cross-sectional view of one embodiment of projections extending outward from the surface of the innersphere of the golf ball of the present invention.

FIG. 8 is a cross-sectional view of a preferred embodiment of projections of the golf ball of the present invention.

FIG. 9 is a front view of the preferred embodiment of the golf ball of the present invention illustrating the alternating parting line.

FIG. 9A is a perspective view of the golf ball of FIG. 9.

FIG. 9B is a polar view of the golf ball of FIG. 9.

FIG. 9C is an identical view of FIG. 9 illustrating the pentagonal grouping of hexagons.

FIG. 10 is a graph of the lift coefficient versus Reynolds number for traditional

golf balls.

FIG. 11 is graph of the drag coefficient versus Reynolds number for traditional golf balls.

FIG. 12 is a graph of the lift coefficient versus Reynolds number for the golf ball of the present invention for four different backspins.

FIG. 13 is graph of the drag coefficient versus Reynolds number for the golf ball of the present invention for four different backspins.

FIG. 14 is an enlarged view of the surface of a golf ball of the present invention to demonstrate the minimal volume feature of the present invention.

FIG. 15 is an enlarged view of the surface of a golf ball of the prior art for comparison to the minimal volume feature of the present invention.

FIG. 16 is a chart of the minimal volume.

Best Mode(s) For Carrying Out The Invention

As shown in FIGS. 1-4, a golf ball is generally designated 20. The golf ball may be a two-piece, a three piece golf ball, or a multiple layer golf ball. Further, the three-piece golf ball may have a wound layer, or a solid boundary layer. Additionally, the core of the golf ball 20 may be solid, hollow or filled with a fluid such as a gas or liquid. The cover of the golf ball 20 may be any suitable material. A preferred cover is composed of a thermosetting polyurethane material. However, those skilled in the pertinent art will recognize that other cover materials may be utilized without departing

from the scope and spirit of the present invention. The golf ball 20 may have a finish of a basecoat and/or top coat.

The golf ball 20 has a sphere 21 with an innersphere surface 22. The golf ball 20 also has an equator 24 dividing the golf ball 20 into a first hemisphere 26 and a second hemisphere 28. A first pole 30 is located ninety degrees along a longitudinal arc from the equator 24 in the first hemisphere 26. A second pole 32 is located ninety degrees along a longitudinal arc from the equator 24 in the second hemisphere 28.

Extending outward from the surface 22 of the innersphere 21 are a plurality of projections 40. In a preferred embodiment, the projections 40 are tubular projections. However, those skilled in the pertinent art will recognize that the projections 40 may have other similar shapes. The projections are connected to each other to form a lattice structure 42 on the surface 22 of the innersphere 21. The interconnected projections form a plurality of polygons encompassing discrete areas of the surface 22 of the innersphere 21. Most of these discrete bounded areas 44 are hexagonal shaped bounded areas 44a, with a few pentagonal shaped bounded areas 44b, a few octagonal shaped bounded areas 44c, and a few quadragonal shaped bounded areas 44d. In the embodiment of FIGS. 1-4, there are 380 polygons. In the preferred embodiment, each of the plurality of projections 40 are connected to at least another projection 40. Each of the projections 40 meet at least two other projections 40 at a vertex 46. Most of the vertices 46 are the congruence of three projections 40. However, some vertices 46a are the congruence of four projections 40. These vertices 46a are located at the equator 24

of the golf ball 20. The length of each of the projections 40 ranges from 0.005 inches to 0.01 inches.

Unlike traditional golf balls that attempt to minimize the land area (the non-dimpled area) by packing in various sizes of dimples, the preferred embodiment of the present invention has zero land area since only a line of each of the plurality of projections 40 is in a spherical plane at 1.68 inches. More specifically, the land area of traditional golf balls is the area forming a sphere of at least 1.68 inches for USGA and R&A conforming golf balls. This land area is minimized with dimples that are concave into the surface of the sphere of the traditional golf ball. However, the innersphere 21 of the golf ball 20 of the present invention has a diameter that is less than 1.68 inches. The golf ball 20 of the present invention conforms to the USGA and R&A 1.68 inches diameter requirement due to the height of the projections 40 from the surface 22 of the innersphere 21. The height of the projections 40 are such that the diameter of the golf ball 20 of the present invention meets or exceeds the 1.68 inches requirement. In a preferred embodiment, only a line at the apex of each of the projections 40 meets the 1.68 inches requirement.

Traditional golf balls were designed to have the dimples "trip" the boundary layer on the surface of a golf ball in flight to create a turbulent flow for greater lift and reduced drag. The golf ball 20 of the present invention has the tubular lattice structure 42 to trip the boundary layer of air about the surface of the golf ball 20 in flight.

As shown in FIG. 4A, a phantom 1.68 inches sphere, as shown by dashed line 45,

encompasses the projections 40 and the innersphere 21. The volume of the projections 40 as measured from the surface 22 of the innersphere to the apex 50 is a minimal amount of the volume between the phantom 1.68 inches sphere and the innersphere 21. In the preferred embodiment, the apex 50 lies on the phantom 1.68 inches sphere. Thus, over 90 percent, and closer to 95 percent, of the entire surface of the golf ball 20 lies below the 1.68 inches phantom sphere.

As shown in FIGS. 5 and 6, the height h and h' of the projections 40 from the surface 22 to an apex 50 will vary in order to have the golf ball 20 meet or exceed the 1.68 inches requirement. For example, if the diameter of the innersphere 21 is 1.666 inches, then the height h of the projections 40 in FIG. 5 is 0.007 inches since the projection 40 on one hemisphere 26 is combined with a corresponding projection 40 on the second hemisphere 28 to reach the 1.68 inches requirement. In a preferred embodiment, if projections 40 having a greater height h' are desired, such as in FIG.6, then the innersphere 21 is reduced in diameter. Thus, the diameter of the innersphere 21 in FIG. 6 is 1.662 while the height h' of the projections 40 are 0.009. As shown in FIG. 6A, the width of each of the apices 50 is minimal since the apex lies along an arc of a projection 40. In theory, the width of each apex 50 should approach the width of a line. In practice, the width of each apex 50 of each projection 40 is determined by the precision of the mold utilized to produce the golf ball 20. The precision of the mold is itself determined by the master used to form the mold. In the practice, the width of each line ranges from 0.0001 inches to 0.001 inches.

Although the cross-section of the projections 40 shown in FIGS. 5 and 6 are circular, a preferred cross-section of each the plurality of projections 40 is shown in FIGS. 7 and 8. In such a preferred cross-section, the projection 40 has a contour 52 that has a first concave section 54, a convex section 56 and a second concave section 58. The radius R_2 of the convex portion 56 of each of the projections 40 is preferably in the range of 0.0275 inches to 0.0350 inches. The radius R_1 of the first and second concave portions 54 and 58 is preferably in the range of 0.150 inches to 0.200 inches, and most preferably 0.175 inches. R_{ball} is the radius of the innersphere which is preferably 0.831 inches.

A preferred embodiment of the present invention is illustrated in FIGS. 9, 9A, 9B and 9C. In this embodiment, the golf ball 20 has a parting line 100 that corresponds to the shape of polygon defined by the plurality of projections 40 about the equator 24. Thus, if the polygons have a hexagonal shape, the parting line 100 will alternate along the lower half of one hexagon and the upper half of an adjacent hexagon. The preferred embodiment allows for greater uniformity in the polygons. In the embodiment of FIGS. 9, 9A, 9B and 9C, there are 332 polygons, with 12 of those polygons being pentagons and the rest being hexagons.

As shown in FIG. 9, each hemisphere 26 and 28 has two rows of hexagons 70, 72, 74 and 76, adjacent the parting line 100. The pole 30 of the first hemisphere 26 is encompassed by a pentagon 44b, as shown in FIG. 9B. The pentagon 44b at the pole 30 is encompassed by ever increasing spherical pentagonal groups of hexagons 80, 82,

84, 86, and 88. A pentagonal group 90 has pentagons 44b at each respective base, with hexagons 44a therebetween. The pentagonal groups 80, 82, 84, 86, 88 and 90 transform into the four adjacent rows 70, 72, 74 and 76. The preferred embodiment only has hexagons 44a and pentagons 44b.

FIGS. 10 and 11 illustrate the lift and drag of traditional golf balls at a backspin of 2000 rpm and 3000 rpm, respectively. FIGS. 12 and 13 illustrate the lift and drag of the present invention at four different backspins. The force acting on a golf ball in flight is calculated by the following trajectory equation:

$$F = F_L + F_D + G \qquad \text{(A)}$$

wherein F is the force acting on the golf ball; F_L is the lift; F_D is the drag; and G is gravity. The lift and the drag in equation A are calculated by the following equations:

$$F_L = 0.5 C_L A \rho v^2 \qquad \text{(B)}$$

$$F_D = 0.5 C_D A \rho v^2 \qquad \text{(C)}$$

wherein C_L is the lift coefficient; C_D is the drag coefficient; A is the maximum cross-sectional area of the golf ball; ρ is the density of the air; and v is the golf ball airspeed.

The drag coefficient, C_D, and the lift coefficient, C_L, may be calculated using the following equations:

$$C_D = 2F_D / A \rho v^2 \qquad \text{(D)}$$

$$C_L = 2F_L / A \rho v^2 \qquad \text{(E)}$$

The Reynolds number R is a dimensionless parameter that quantifies the ratio of inertial to viscous forces acting on an object moving in a fluid. Turbulent flow for a

dimpled golf ball occurs when R is greater than 40000. If R is less than 40000, the flow may be laminar. The turbulent flow of air about a dimpled golf ball in flight allows it to travel farther than a smooth golf ball.

The Reynolds number R is calculated from the following equation:

$$R = vD\rho/\mu \qquad \text{(F)}$$

wherein v is the average velocity of the golf ball; D is the diameter of the golf ball (usually 1.68 inches); ρ is the density of air (0.00238 slugs/ft^3 at standard atmospheric conditions); and μ is the absolute viscosity of air (3.74×10^{-7} lb*sec/ft^2 at standard atmospheric conditions). A Reynolds number, R, of 180,000 for a golf ball having a USGA approved diameter of 1.68 inches, at standard atmospheric conditions, approximately corresponds to a golf ball hit from the tee at 200 ft/s or 136 mph, which is the point in time during the flight of a golf ball when the golf ball attains its highest speed. A Reynolds number, R, of 70,000 for a golf ball having a USGA approved diameter of 1.68 inches, at standard atmospheric conditions, approximately corresponds to a golf ball at its apex in its flight, 78 ft/s or 53 mph, which is the point in time during the flight of the golf ball when the travels at its slowest speed. Gravity will increase the speed of a golf ball after its reaches its apex.

FIG. 10 illustrates the lift coefficient of traditional golf balls such as the Titlelist PROFESSIONAL, the Titlelist TOUR PRESTIGE, the Maxfli REVOLUTION and the Maxfli HT URETHANE. FIG. 11 illustrates the drag coefficient of traditional golf balls such as the Titlelist PROFESSIONAL, the Titlelist TOUR PRESTIGE, the Maxfli

REVOLUTION and the Maxfli HT URETHANE.

All of the golf balls for the comparison test, including the golf ball 20 of the present invention, have a thermoset polyurethane cover. The golf ball 20 of the present invention was constructed as set forth in U.S. Patent Number 6,117,024, for a Golf Ball With A Polyurethane Cover. However, those skilled in the pertinent art will recognize that other materials may be used in the construction of the golf ball of the present invention. The aerodynamics of the tubular lattice pattern of the present invention provides a greater lift with a reduced drag thereby translating into a golf ball 20 that travels a greater distance than traditional golf balls of similar constructions.

As compared to traditional golf balls, the golf ball 20 of the present invention is the only one that combines a lower drag coefficient at high speeds, and a greater lift coefficient at low speeds. Specifically, as shown in FIGS. 10-13, none of the other golf balls have a lift coefficient, C_L, greater than 0.18 at a Reynolds number of 70,000, and a drag coefficient C_D less than 0.23 at a Reynolds number of 180,000. For example, while the Titliest PROFESSIONAL has a C_L greater than 0.18 at a Reynolds number of 70,000, its C_D is greater than 0.23 at a Reynolds number of 180,000. Also, while the Maxfli REVOLUTION has a drag coefficient C_D greater than 0.23 at a Reynolds number of 180,000, its C_L is less than 0.18 at a Reynolds number of 70,000.

In this regard, the Rules of Golf, approved by the USGA and The R&A, limits the initial velocity of a golf ball to 250 feet (76.2m) per second (a two percent maximum tolerance allows for an initial velocity of 255 per second) and the overall distance to

280 yards (256m) plus a six percent tolerance for a total distance of 296.8 yards (the six percent tolerance may be lowered to four percent). A complete description of the Rules of Golf are available on the USGA web page at www.usga.org. Thus, the initial velocity and overall distance of a golf ball must not exceed these limits in order to conform to the Rules of Golf. Therefore, the golf ball 20 should have a dimple pattern that enables the golf ball 20 to meet, yet not exceed, these limits.

FIG. 14 is an enlarged view of the surface of the golf ball 20 of the present invention to demonstrate the minimal volume of the golf ball 20 from a predetermined distance from the greatest extent of the golf ball 20. More specifically, the greatest extent of one embodiment of the golf ball 20 are the apices 50 of the projections 40 which lie on a spherical plane (shown as dashed line 45) which has a 1.682 inches diameter. Those skilled in the art should recognize that other embodiments could have the apices 50 lie on a spherical plane at 1.70 inches, 1.72 inches, 1.64 inches, 1.60 inches, or any other variation in the diameter of the greatest extent of the golf ball 20. Having defined the greatest extent of the golf ball 20, the present invention will have a minimal volume from this greatest extent toward the innersphere 22. For example, dashed line 130 represents a spherical plane that intersects each of the projections 40 at a distance of 0.002 inches (at a radius of 0.839 inches from the center) from the greatest extent of the golf ball 20. The volume of the golf ball 20 of the present invention between the greatest extent spherical plane 45 and the spherical plane 130 is only 0.0008134 cubic inches. In other words, the outermost 0.002 inches (between a radius

of 0.841 and 0.839 inches) of the golf ball 20 has a volume 0.0008134 cubic inches.

FIG. 15 illustrates the surface of a golf ball 140 of the prior art which has traditional dimples 142 encompassed by a land area 144. The land area 144 represents the greatest extent of the golf ball 140 of the prior art. For comparison to the golf ball 20 of the present invention, the volume of the golf ball 140 of the prior art between the greatest extent 144 and a spherical plane 130' is 0.00213 cubic inches. Spherical planes 132, 134 and 136, at 0.004 inches, 0.006 inches and 0.008 inches respectively, have volumes of 0.0023074 cubic inches, 0.0042164 cubic inches and 0.0065404 cubic inches, respectively on the golf ball 20 of the present invention. While spherical planes 132', 134' and 136', at 0.004 inches, 0.006 inches and 0.008 inches respectively, will have volumes of 0.00498 cubic inches, 0.00841 cubic inches and 0.01238 cubic inches on the golf ball 140 of the prior art 140.

Thus, as further shown in FIG. 16 and Table One below, the golf ball 20 of the present invention will have a minimal volume at a predetermined distance from the greatest extent of the golf ball 20. This minimal volume is a minimal amount necessary to trip the boundary layer air at low speed while providing a low drag level at high speeds. The first column of Table One is the distance from the outermost point of the golf ball 20, which is the apex 50 of each of the projections 40. The second column is the individual volume of each of the 830 tubes at this distance inward from the outermost point. The third column is the total volume of the spherical planes at each distance inward from the outermost point. Table Two contains similar information for

the golf ball 140 of the prior art.

Table One

Tube H	Tube Vol	Total Volume
0.001	0.00000035	0.0002905
0.002	0.00000098	0.0008134
0.003	0.00000181	0.0015023
0.004	0.00000278	0.0023074
0.005	0.00000387	0.0032121
0.006	0.00000508	0.0042164
0.007	0.00000641	0.0053203
0.008	0.00000788	0.0065404
0.009	0.00001123	0.0093209

Table Two

Shell Delta Dia.	1/10 Remaining Vol	Total Remaining Vol
0.001	0.000091	0.00091
0.002	0.000213	0.00213
0.003	0.000347	0.00347
0.004	0.000498	0.00498
0.005	0.000663	0.00663
0.006	0.000841	0.00841
0.007	0.001033	0.01033
0.008	0.001238	0.01238
0.009	0.001458	0.01458

Claims

1. A golf ball comprising:

an innersphere having a surface;

a plurality of tubular projections disposed on the innersphere surface, each of the tubular projections having a cross-sectional curvature, the plurality of tubular projections connected to each other to form a predetermined pattern on the surface, each of the tubular projections extending from 0.005 inches to 0.010 inches from the innersphere surface.

2. The golf ball according to claim 1 wherein the plurality of tubular projections cover between 20% to 80% of the surface of the innersphere surface.

3. The golf ball according to claim 1 wherein each of the plurality of tubular projections has an apex with a width less than 0.00001 inches.

4. The golf ball according to claim 3 wherein the diameter of the innersphere is at least 1.67 inches and the height of the apex of each of the plurality of connected tubes is at least 0.005 inches from the surface of the innersphere.

5. The golf ball according to claim 1 further comprising a plurality of smooth portions on the innersphere surface wherein the plurality of smooth portions and the plurality of tubular projections cover the entire innersphere surface.

6. The golf ball according to claim 5 wherein the plurality of tubular projections form a plurality of polygons about the plurality of smooth portions.

7. The golf ball according to claim 6 wherein the each of the plurality of polygons is either a hexagon or a pentagon.

8. The golf ball according to claim 1 wherein the curvature of each of the plurality of tubular projections has a convex section juxtaposed by a first concave section and a second concave section, both concave sections nearest the innersphere surface.

9. The golf ball according to claim 1 wherein the curvature of each of the plurality of tubular projections is convex.

10. A golf ball comprising:

an innersphere having a surface; and

a plurality of tubular projections disposed on the innersphere surface, each of the tubular projections having a cross-sectional curvature with an arc, the plurality of tubular projections connected to each other to form a plurality of interconnected polygons;

wherein the tubular projections cover between 20% and 80% of the surface of the golf ball.

11. The golf ball according to claim 10 wherein the arc of each of the plurality of tubular projections has an arc with a width less than 0.00001 inches.

12. The golf ball according to claim 11 wherein the diameter of the sphere is at least 1.67 inches and the height of the apex of each of the plurality of tubular projections is at least 0.005 inches from the surface of the sphere.

13. The golf ball according to claim 10 further comprising a plurality of smooth portions on the innersphere surface wherein the plurality of smooth portions and the plurality of tubular projections cover the entire innersphere surface.

14. The golf ball according to claim 10 wherein the plurality of polygons are either hexagons or pentagons.

15. A golf ball comprising:

a sphere having a diameter in the range of 1.60 to 1.70; and

a tubular lattice configuration disposed on the sphere, the tubular lattice configuration comprising a plurality of connected tubes extending outward from the sphere, each of the tubes having an apex that extends from a surface of the sphere in a range of 0.005 to 0.010.

16. A non-dimpled golf ball comprising:

a sphere having a diameter in the range of 1.60 to 1.76;

a plurality of connected tubes extending outward from the sphere, each of the tubes having an apex that extends from a surface of the sphere in a range of 0.005 to 0.010;

a plurality of smooth portions on the surface; and

wherein the entire surface of the golf ball is composed of the plurality of connected tubes and the plurality of smooth portions.

17. The non-dimpled golf ball according to claim 16 wherein the apex of each of the plurality of connected tubes has a width less than 0.00001 inches.

18. The non-dimpled golf ball according to claim 16 wherein the diameter of the sphere is at least 1.67 inches and the height of the apex of each of the plurality of connected tubes is at least 0.005 inches from the surface of the sphere.

19. The non-dimpled golf ball according to claim 16 wherein the plurality of connected tubes form a plurality of polygons about the plurality of smooth portions.

20. The non-dimpled golf ball according to claim 19 wherein the plurality of polygons are either hexagons or pentagons.

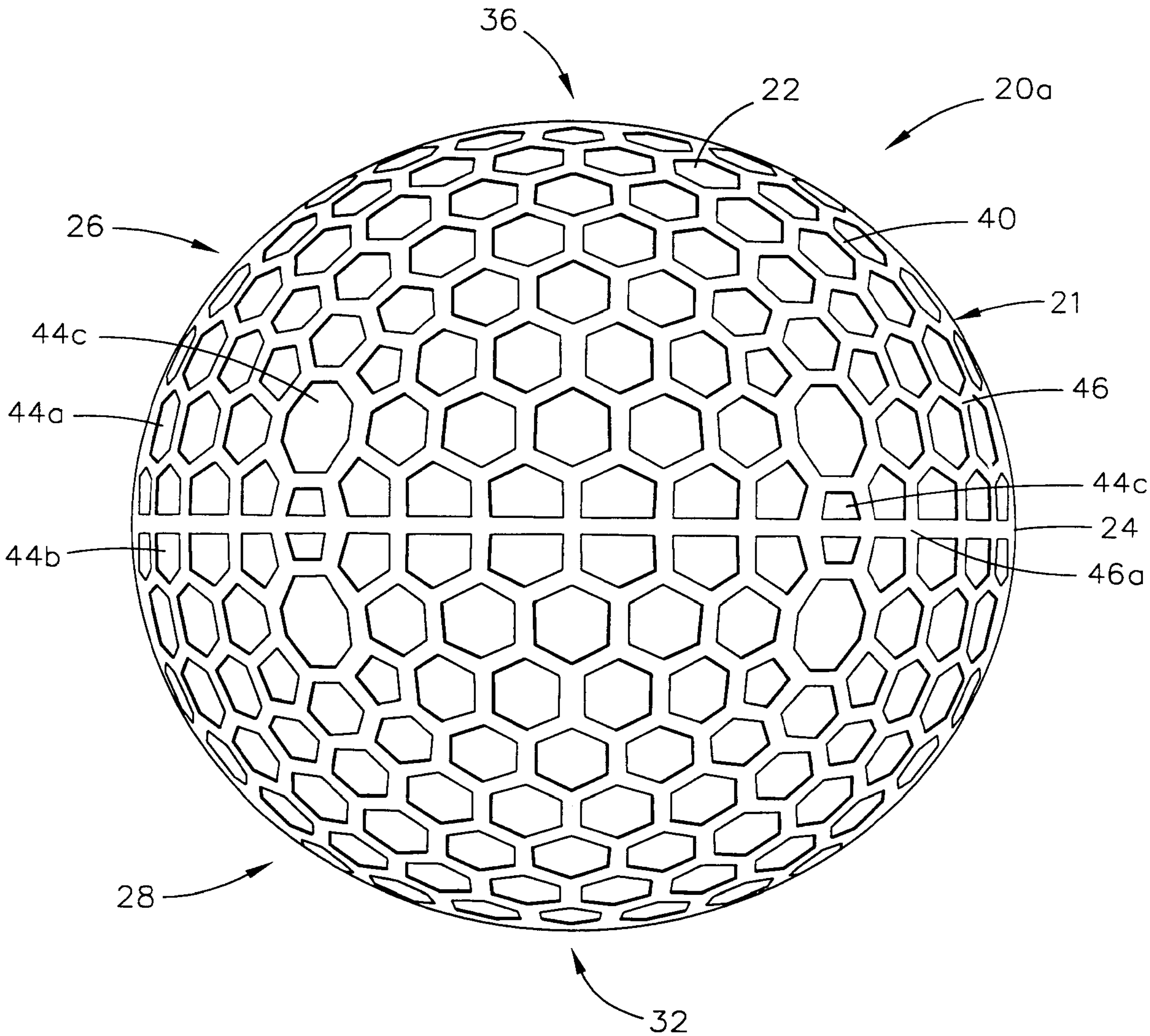


FIG. 1

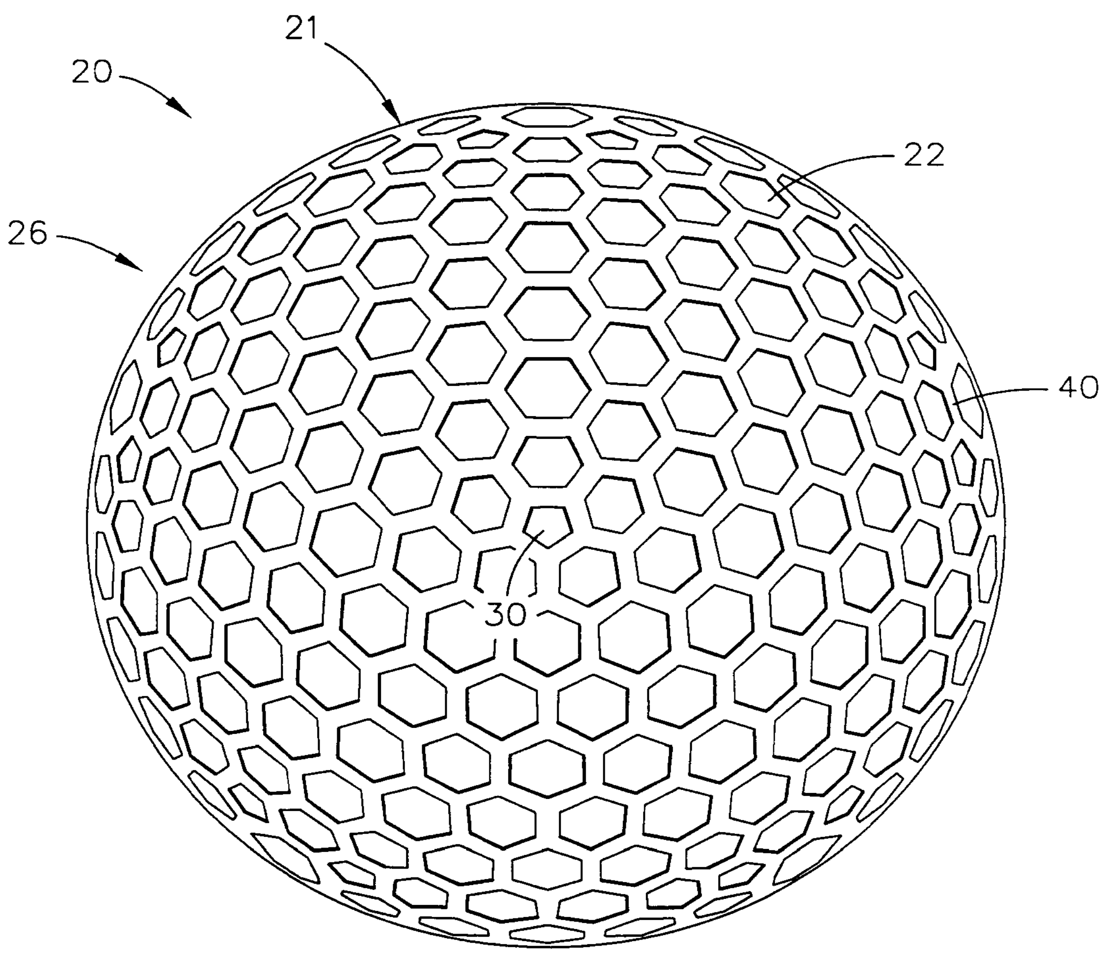


FIG. 2

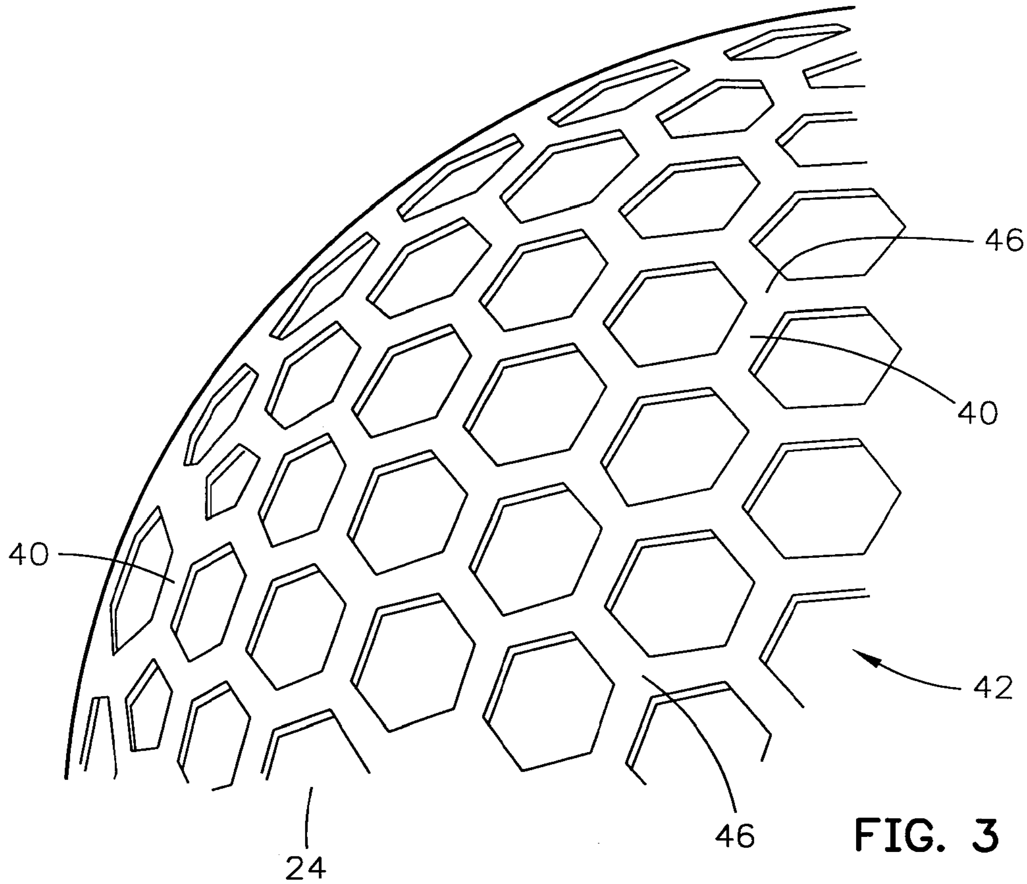


FIG. 3

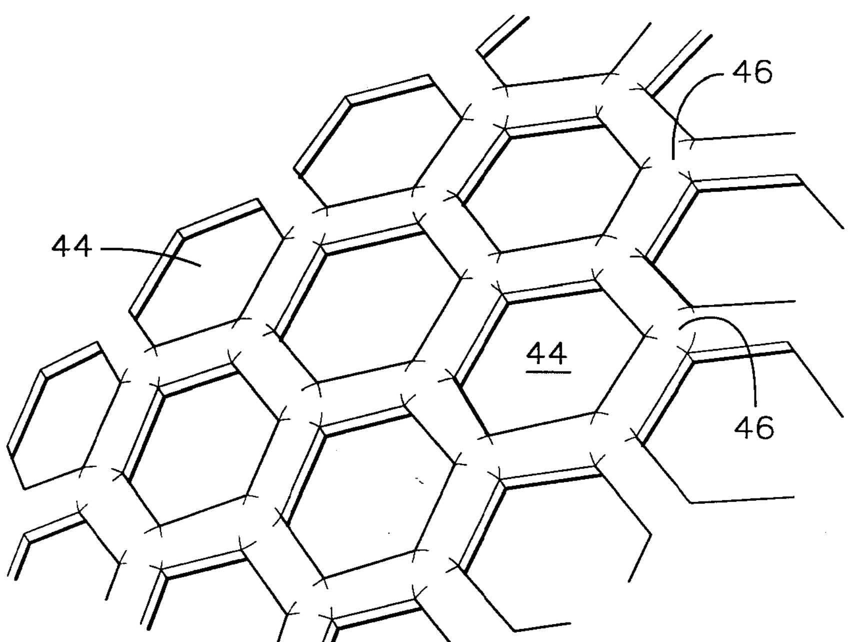


FIG. 4

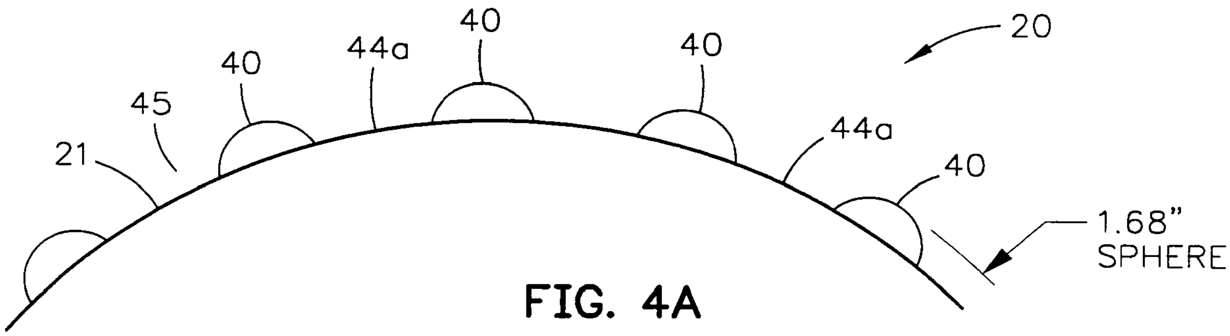


FIG. 4A

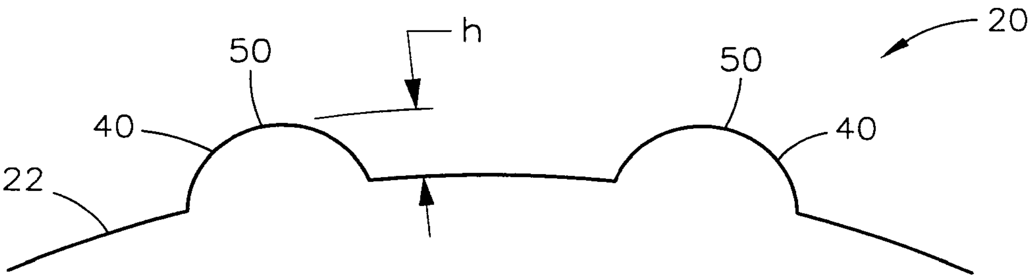


FIG. 5

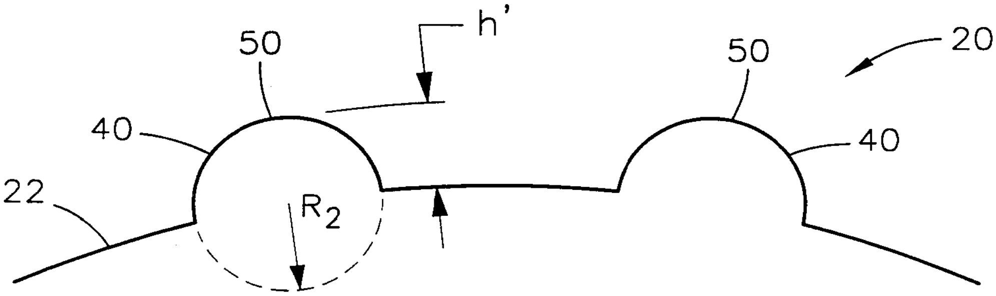


FIG. 6

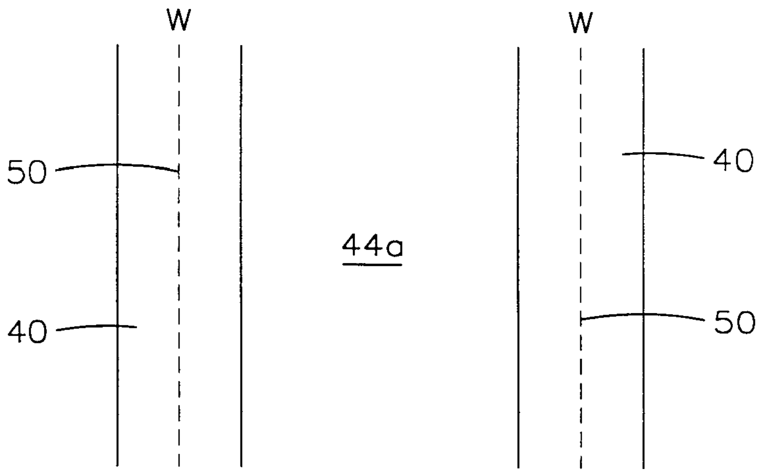


FIG. 6A

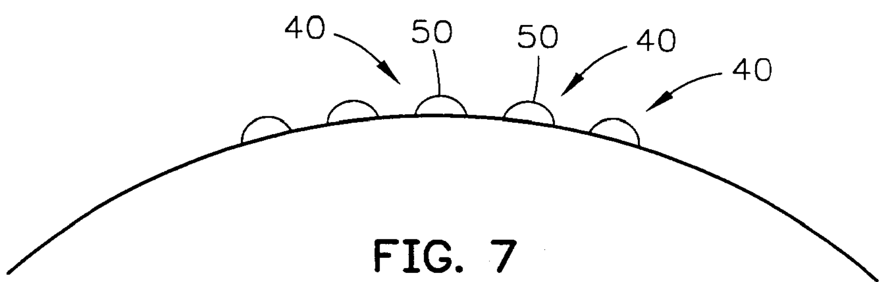


FIG. 7

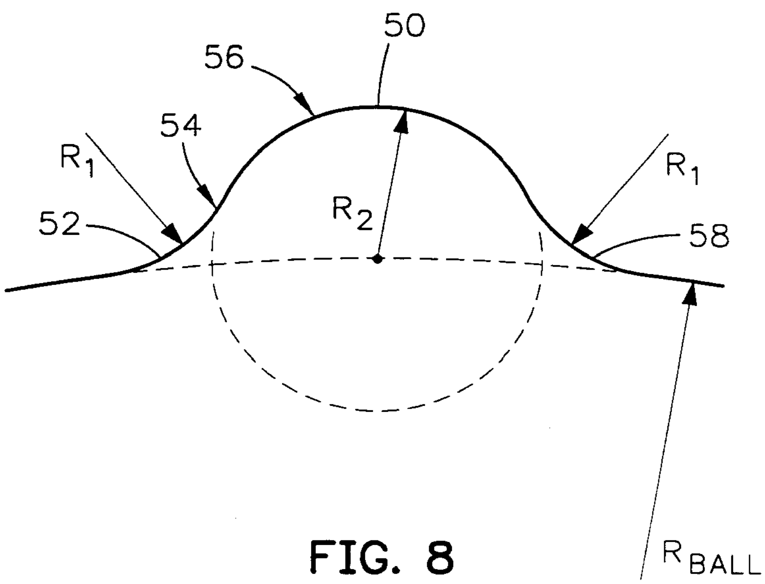


FIG. 8

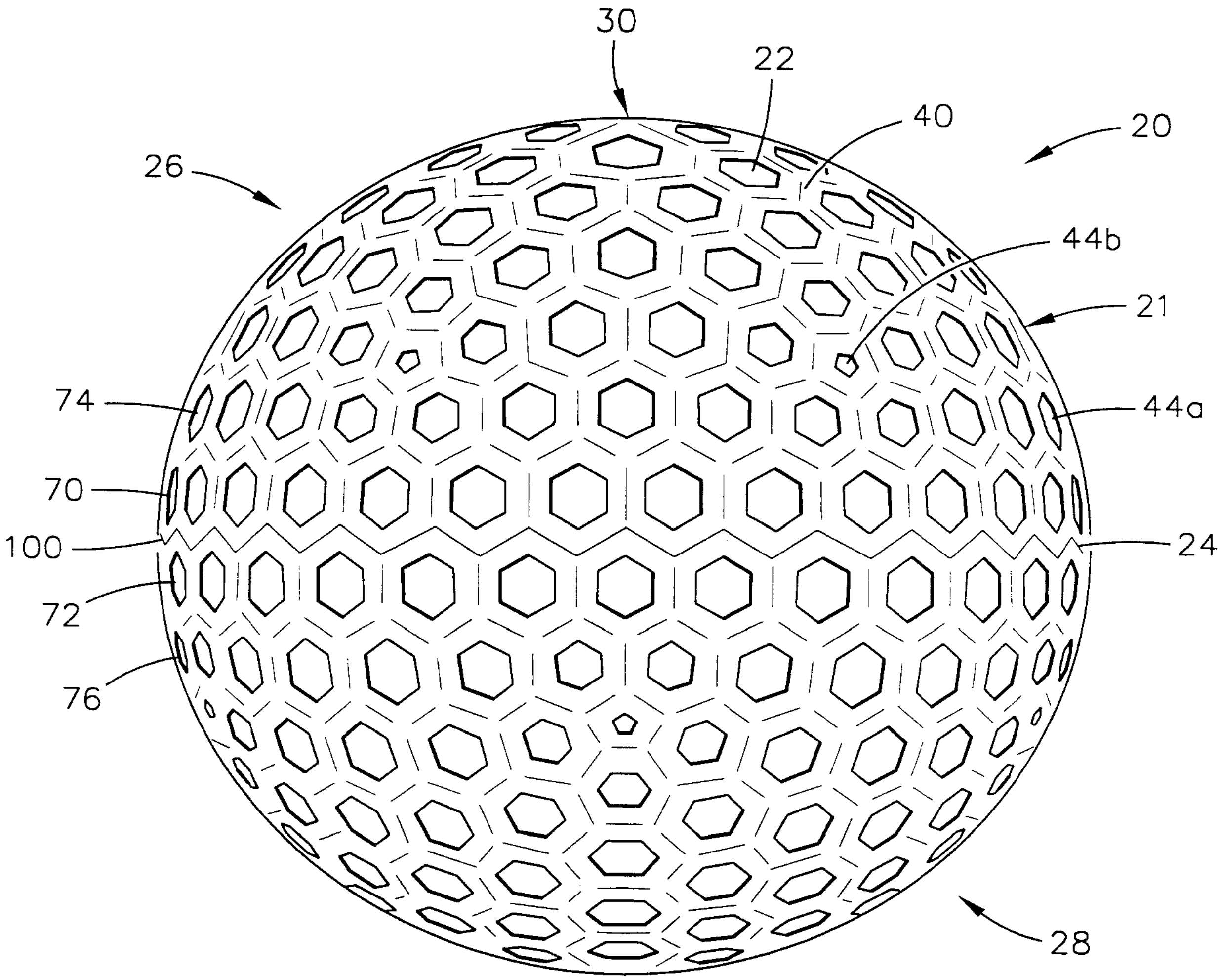


FIG. 9

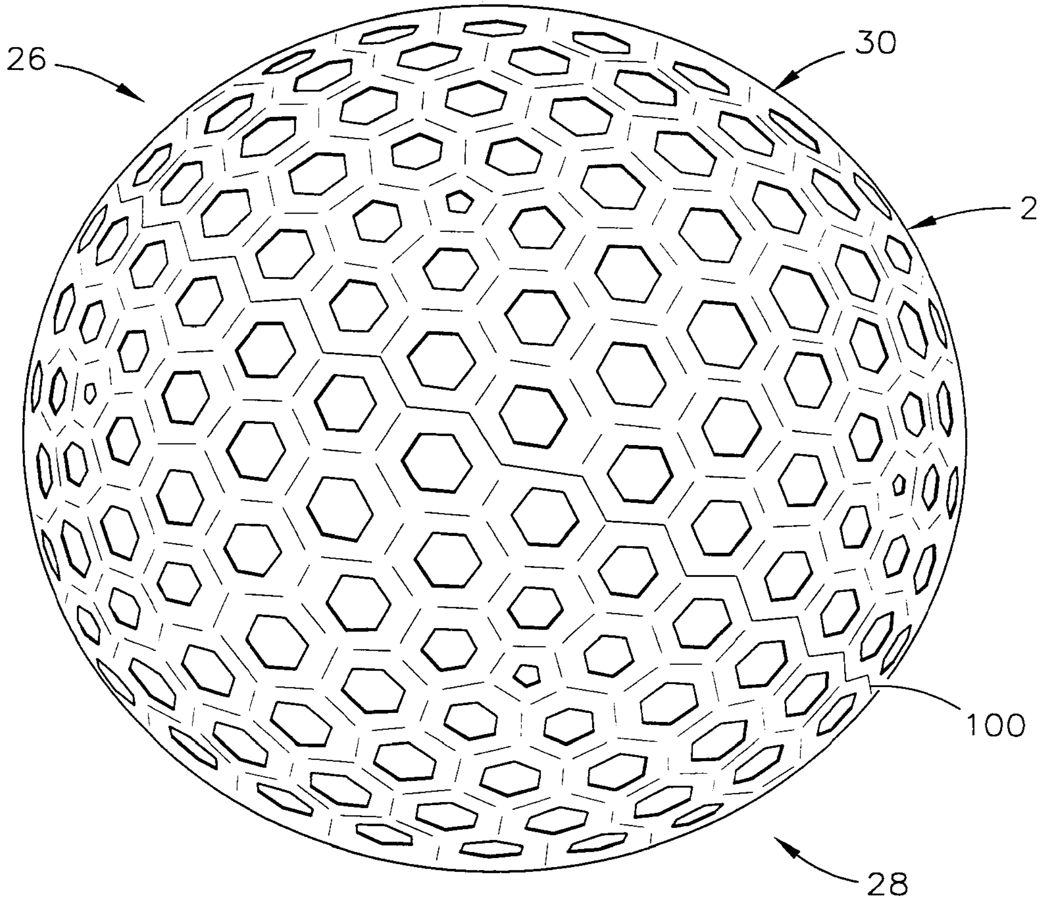


FIG. 9A

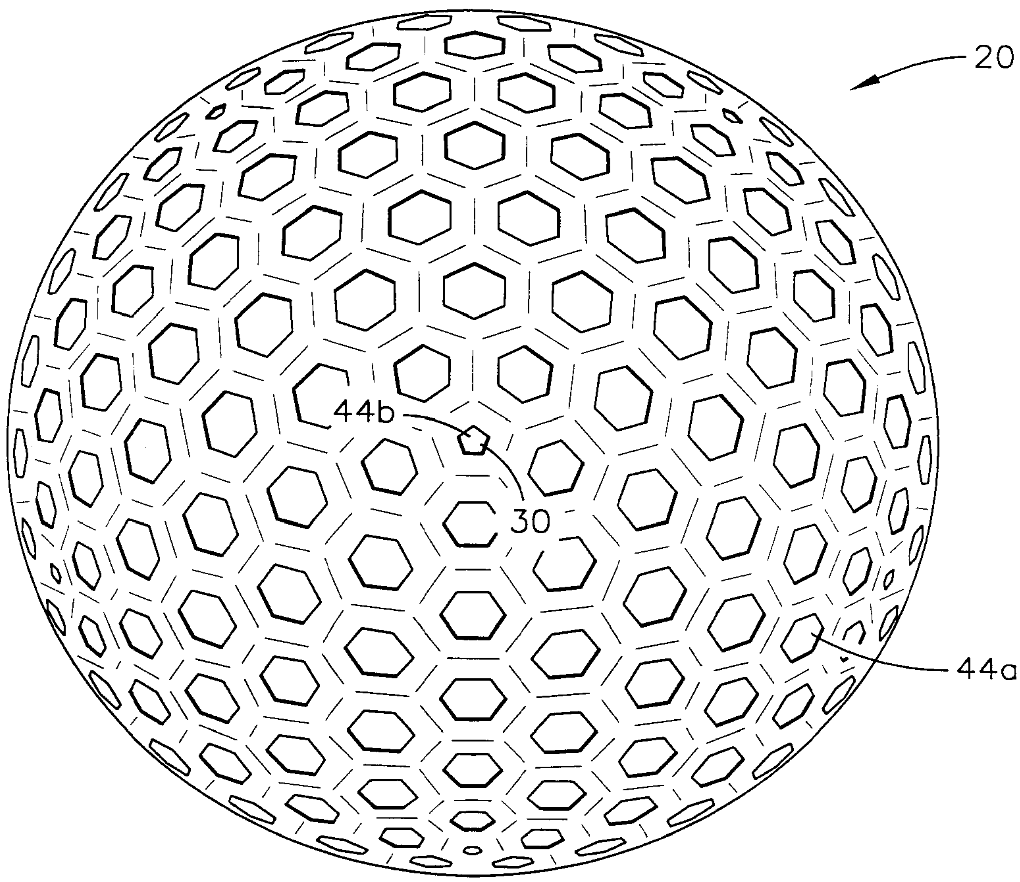


FIG. 9B

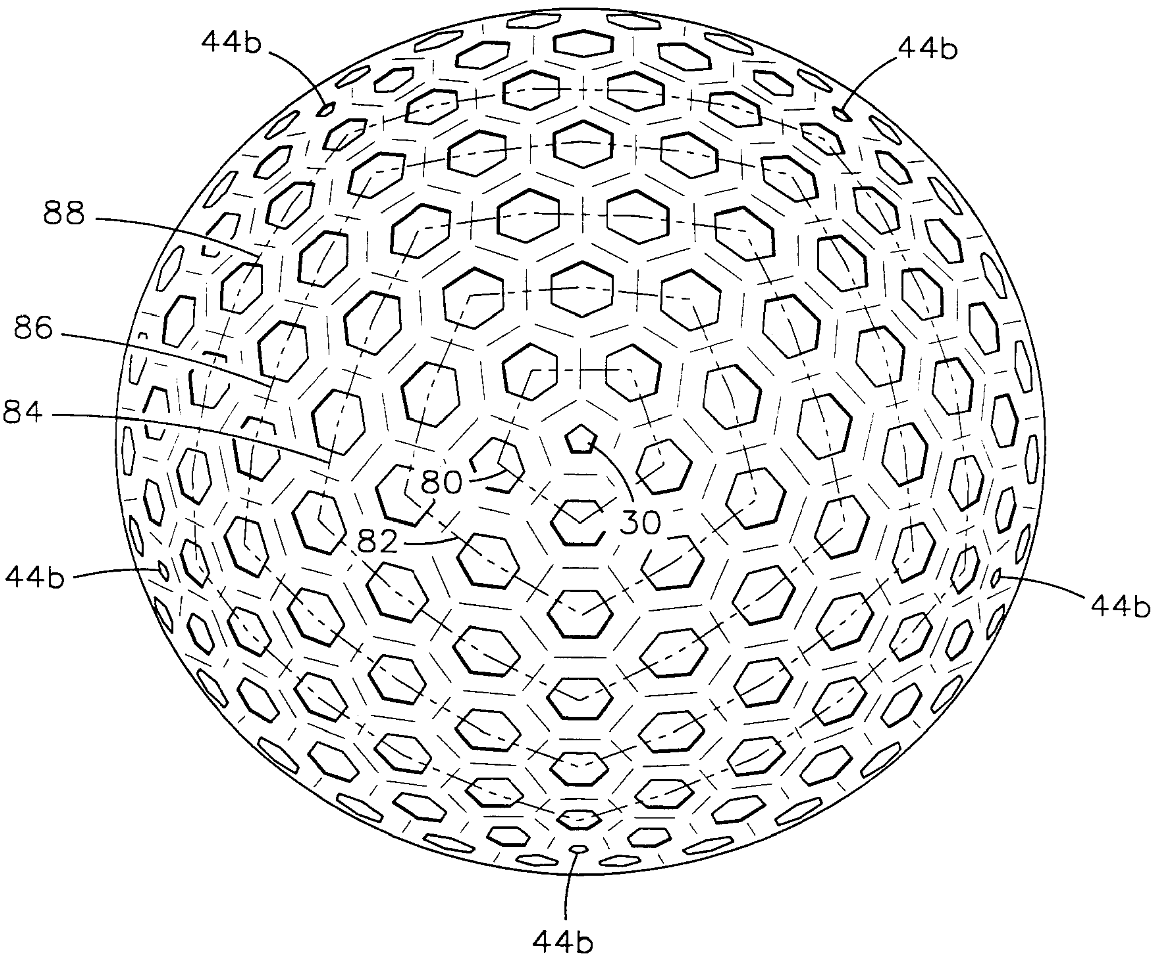


FIG. 9C

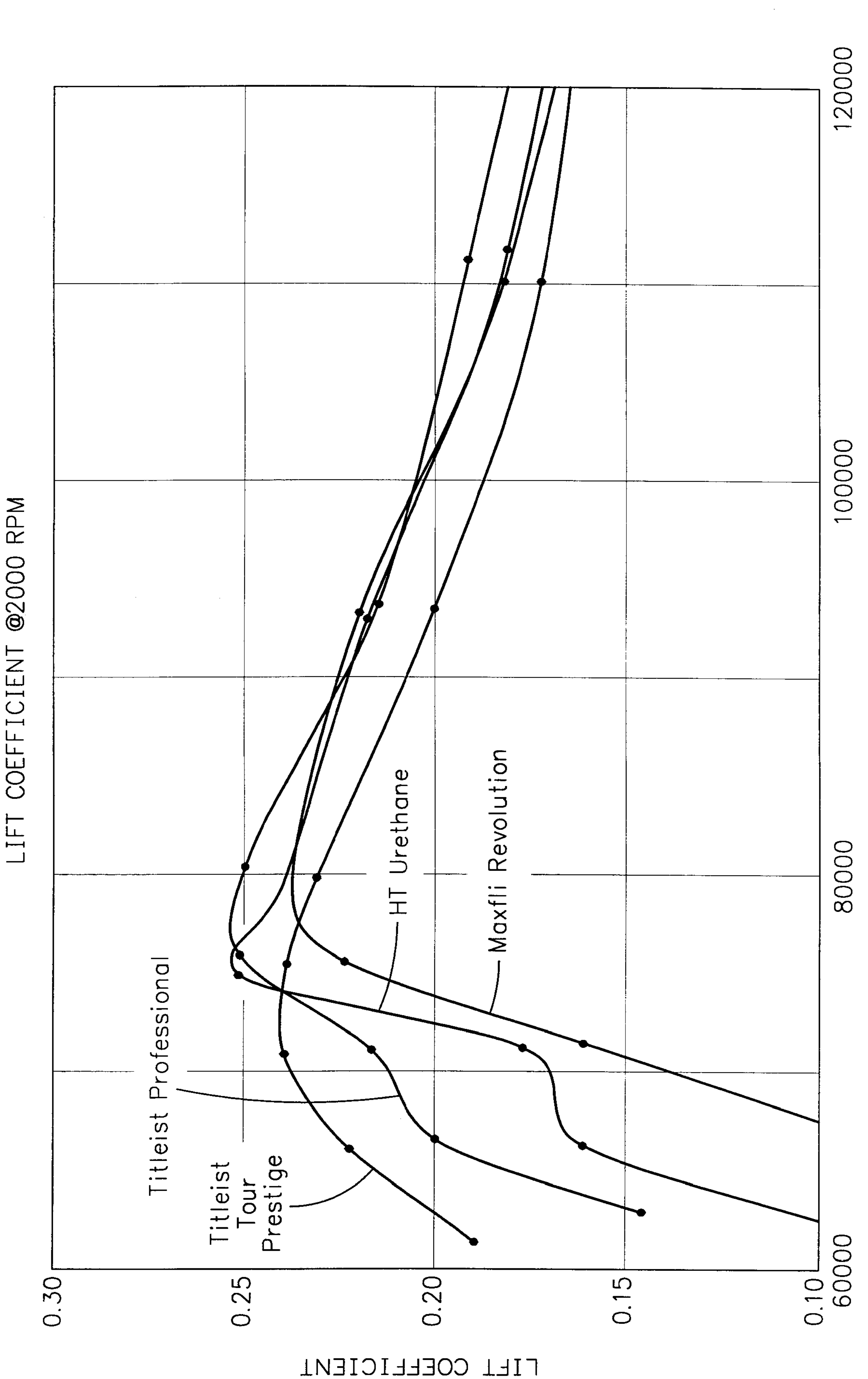
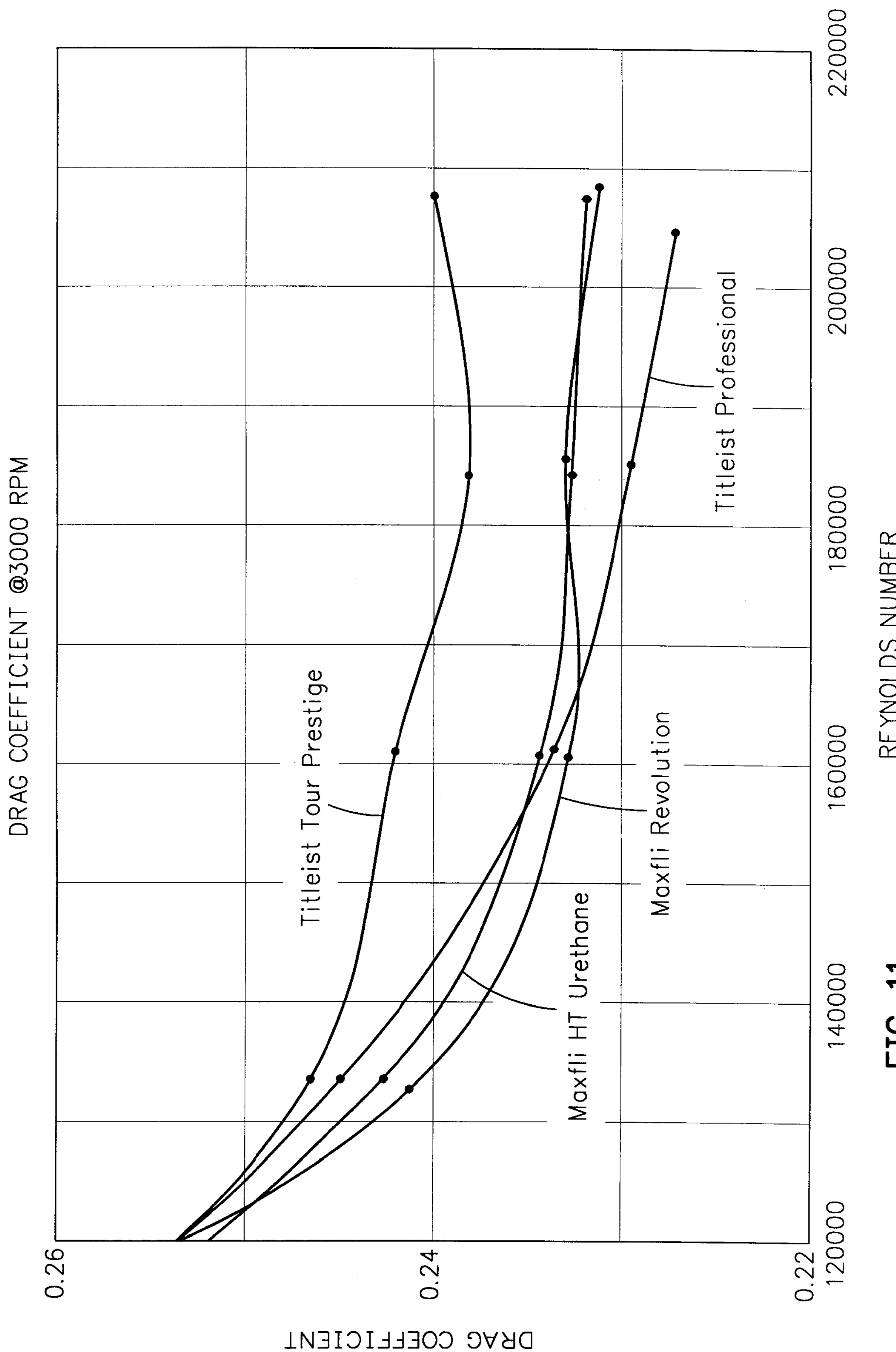

LIFT COEFFICIENT @2000 RPM
LIFT COEFFICIENT
REYNOLDS NUMBER
0.30
0.25
0.20
0.15
0.10
60000
80000
100000
120000
Titleist Professional
Titleist Tour Prestige
HT Urethane
Maxfli Revolution

FIG. 10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Titleist Tour Prestige
Maxfli HT Urethane
Maxfli Revolution
Titleist Professional
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160000
180000
200000
220000
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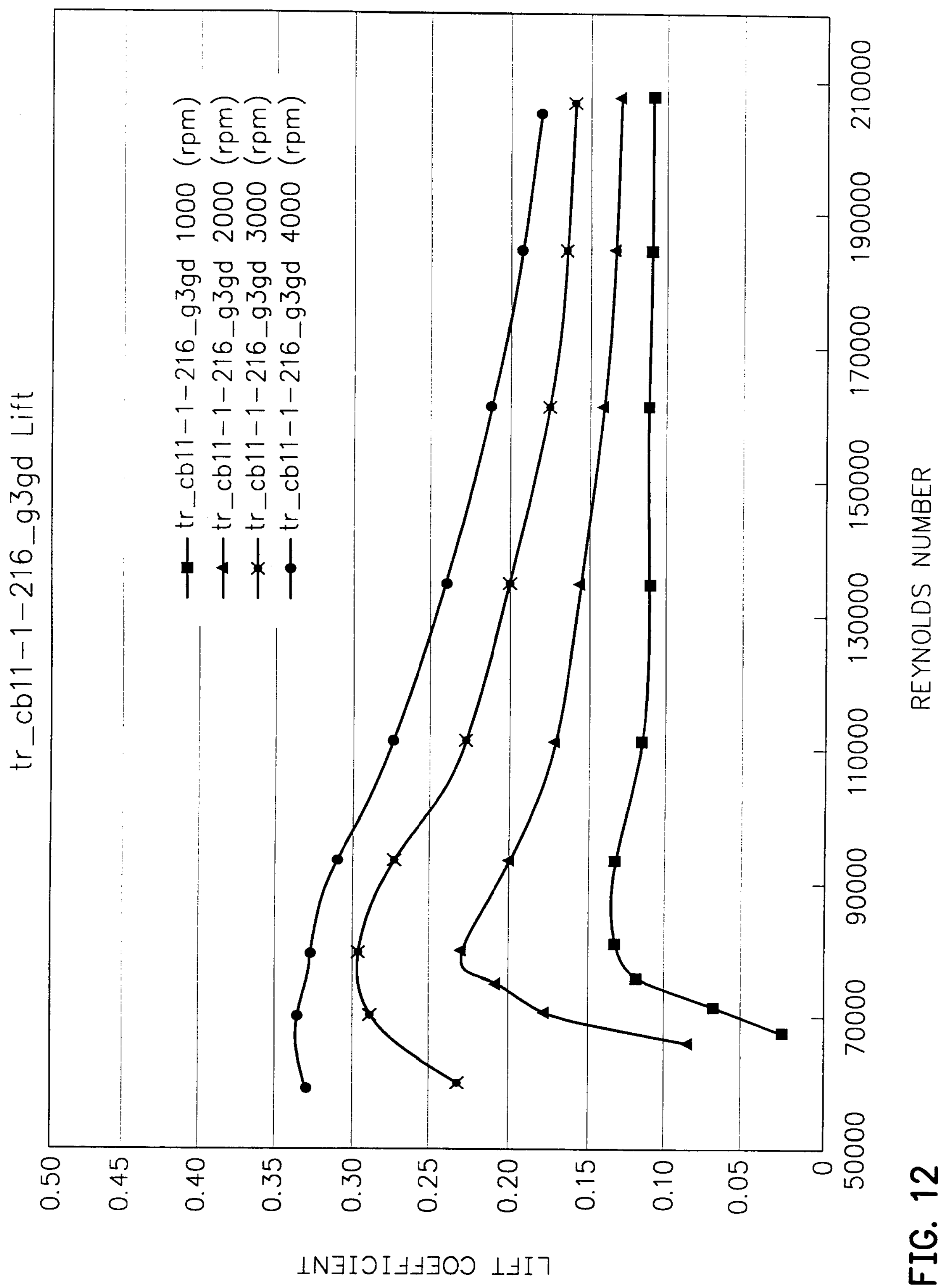
0.24
0.22
DRAG COEFFICIENT

FIG. 11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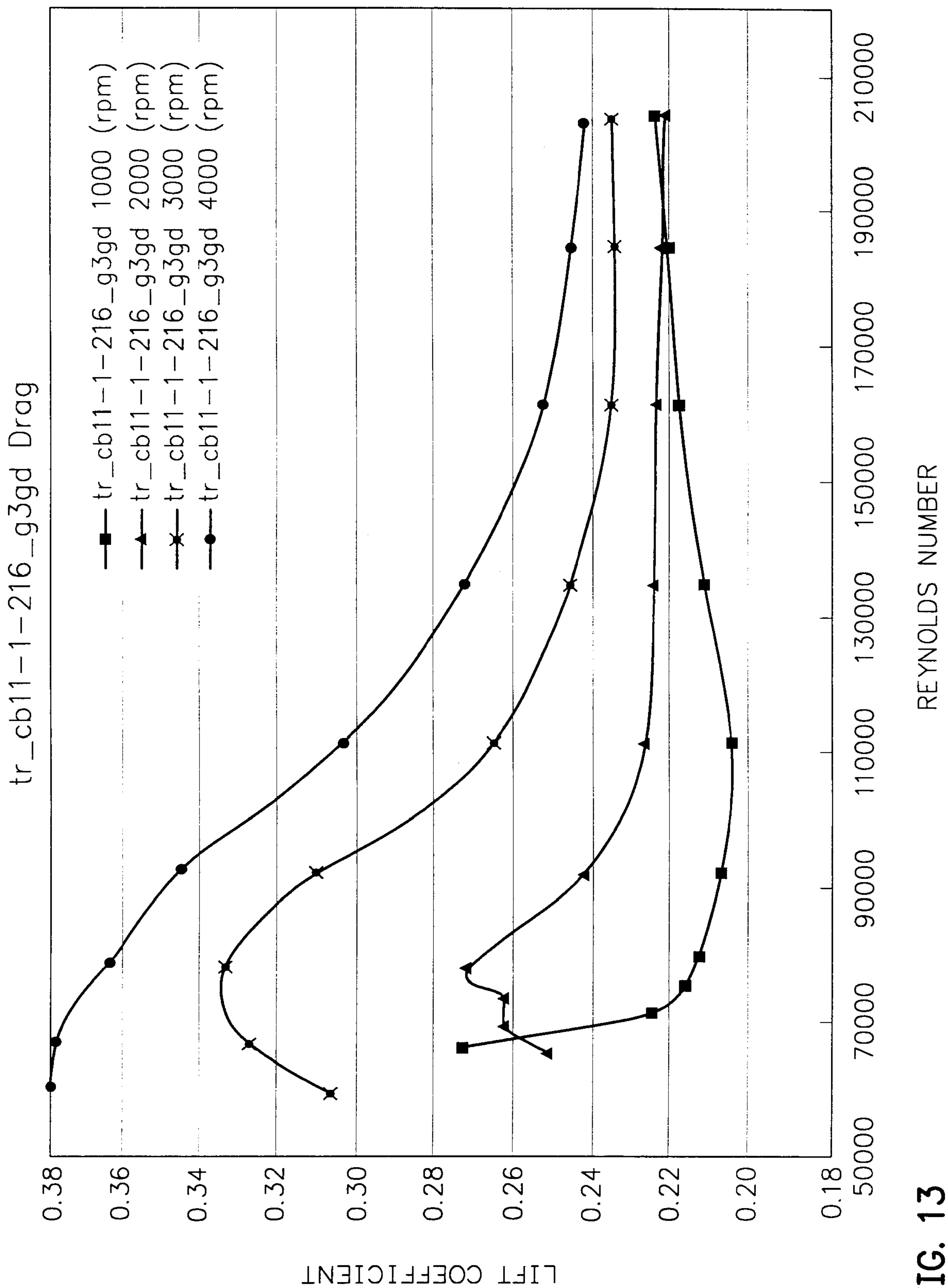
tr_cb11-1-216_g3gd 1000 (rpm)
tr_cb11-1-216_g3gd 2000 (rpm)
tr_cb11-1-216_g3gd 3000 (rpm)
tr_cb11-1-216_g3gd 4000 (rpm)
LIFT COEFFICIENT
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0
50000
70000
90000
110000
130000
150000
170000
190000
210000
REYNOLDS NUMBER

FIG. 12



tr_cb11-1-216_g3gd Drag
tr_cb11-1-216_g3gd 1000 (rpm)
tr_cb11-1-216_g3gd 2000 (rpm)
tr_cb11-1-216_g3gd 3000 (rpm)
tr_cb11-1-216_g3gd 4000 (rpm)
LIFT COEFFICIENT
0.38
0.36
0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
REYNOLDS NUMBER
50000
70000
90000
110000
130000
150000
170000
190000
210000

FIG. 13

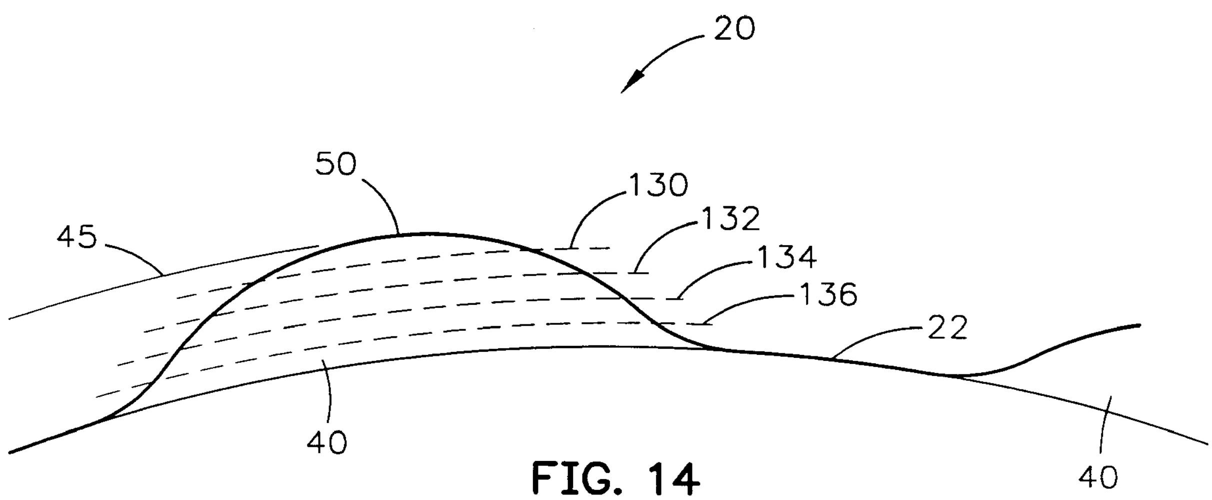


FIG. 14

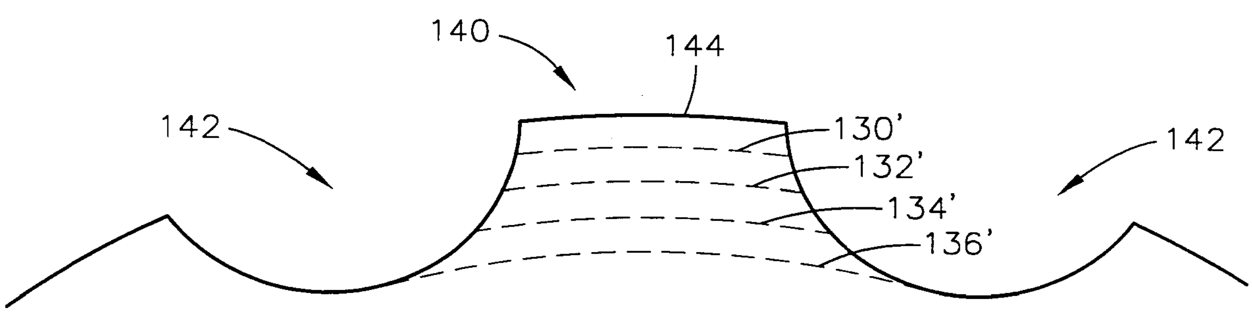


FIG. 15
(PRIOR ART)

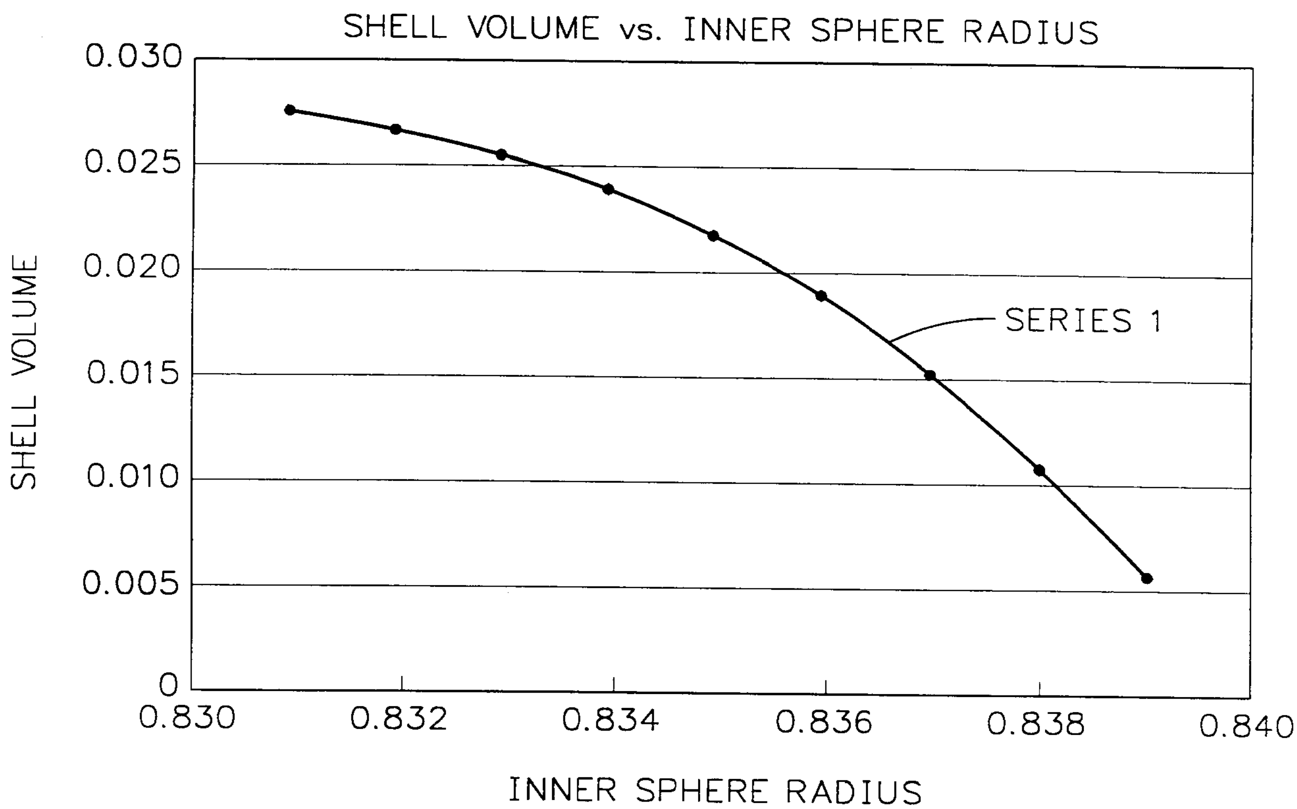

SHELL VOLUME vs. INNER SPHERE RADIUS
0.030
0.025
0.020
0.015
0.010
0.005
0
SHELL VOLUME
SERIES 1
0.830
0.832
0.834
0.836
0.838
0.840
INNER SPHERE RADIUS

FIG. 16

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/31777

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : A63B 37/12
US CL : 473/378

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 473/378, 379, 380, 381, 382, 383, 384, 614

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4,836,552 A (PUCKETT et al) 06 June 1989 (06.06.1989), see all.	1-20

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
09 January 2001 (09.01.2001)	19 JAN 2001

Name and mailing address of the ISA/US	Authorized officer
Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	Mark Graham Sheila Veney Paralegal Specialist Technology Center 3700
Facsimile No. 703-305-3250	Telephone No. 703-308-1355

Form PCT/ISA/210 (second sheet) (July 1998)